Against van Fraassen's observable/unobservable dichotomy

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Abstract

As it is well-known, van Fraassen builds his alternative to scientific realism on top of his observable/unobservable dichotomy. Here it will be defended that this dichotomy cannot be made to stand. However it will also be defended that constructive empiricism does not really needs this dichotomy.

1. Introduction

In *The Scientific Image*, Bas C. van Fraassen presents what he regards to be an empiricist anti-realism. Van Fraassen develops his views against scientific realism. With the realists, van Fraassen shares a commonsensical realism about the world (i.e. there are things, processes, and events around us that we perceive with our senses, and all of this is real). Everything that we perceive with our bare senses van Fraassen calls observable. As it is well-known, physical theories postulate mathematically structured concepts like space, time, fields, and so on. There are versions of scientific realism that tend to regard postulated entities like electrons as ontologically meaningful.[1] While sharing with realists a commonsensical realism, van Fraassen does not goes as far as accepting that putative theoretical entities might be concrete entities (i.e. real). Since the breakdown of the theoretical terms/observational terms dichotomy (theory/observation dichotomy), realists made their case for the possibility of observing what under logical positivism were theoretical terms. For example, Grover Maxwell (1962) considers that due to the impossibility of making a clear theory/observation distinction (since according to Maxwell there is a continuous transition from observable to unobservable) we cannot consider 'electron' to be a theoretical term. Regarding the theory/observation distinction van Fraassen remarks that

> such expressions as 'theoretical entity' and 'observable-theoretical dichotomy' are, on the face of it, examples of category mistakes. Terms or concepts are theoretical (introduced or adapted for the purpose of theory construction); entities are observable or unobservable. This may seem a little point, but it separates the discussion into two issues. Can we divide our language into a theoretical and non-theoretical part? On the other hand, can we classify objects and events into observable and unobservable ones? (van Fraassen 1980, 14)

Van Fraassen accepts the consolidated view that the answer to the first question is negative, but by disentangling from it the second question he can give a positive answer to this question enabling him to promote a new dichotomy that, like the previous one before, can be used, for example, as a barrier to the scientific realist believe on the existence of electrons. With his new dichotomy van Fraassen has the instrument to promote an anti-realist stance. Theories only need to save observable regularities, in this case they have empirical adequacy. This does not imply that the scientific image we are immersed in when accepting a theory has ontological significance regarding the unobservable aspects of the world; we can be agnostic, since the 'immersion in the theoretical world-picture does not preclude 'bracketing' its ontological implications' (van Fraassen 1980, 81).

In part 1 of this paper, I will present an argument defending that van Fraassen's observable/unobservable dichotomy is not tenable. Since van Fraassen's constructive empiricism is (apparently) built on top of this dichotomy its downfall might, at first sight, led to the downfall of van Fraassen's constructive empiricism. I do not think this conclusion can be drawn so easily. I will

[1] Since van Fraassen makes is case against this type of realism I will not consider here other types of realism like structural realism (see, e.g. Ladyman 1998); neither I will consider van Fraassen's later empiricist structuralism (van Fraassen 2008).

argue in part 2, that the downfall of the observable/unobservable dichotomy does not have to bring down constructive empiricism when we simultaneously free ourselves from metaphysical baggage that van Fraassen unwarrantedly adopted when defining the dichotomy.

2. The downfall of the observable/unobservable dichotomy

Van Fraassen sets forward his observable/unobservable dichotomy against Maxwell's argument of the continuum. Maxwell developed his argument in the context of criticizing the theory/observation dichotomy. Van Fraassen called the attention to the fact that it is possible (in his view) to separate the observable/unobservable dichotomy from the theory/observation dichotomy. Van Fraassen accepts that the theory/observation dichotomy is not feasible, but considers that this does not entails anything regarding the observable/unobservable distinction. Maxwell argument goes as follows:

> there is, in principle, a continuous series beginning with looking through a vacuum and containing these as members: looking though a windowpane, looking though glasses, looking through binoculars, looking through a low-power microscope, looking through a high-power microscope, etc. (Maxwell 2009 [1962], 453)

Applied to the observable/unobservable dichotomy, Maxwell's argument of the continuum would imply that there would be no criteria to make the distinction between observable and unobservable. Van Fraassen rejects (I think correctly) Maxwell's argument, because Maxwell does not present anything to justify and characterize what this supposed 'continuum' might be (not even in the case of his example of a set of lenses and microscopes). Van Fraassen considers that even if observable is a vague predicate due to the fact that it is not possible to draw the line between the observable and the unobservable clearly, this does not imply that the dichotomy is meaningless. According to van Fraassen the dichotomy is tenable if we can present clear examples of observable and unobservable things, events, etc. To van Fraassen the moons of Jupiter are observable, not because we can see them using a telescope, but because an astronaut could see them directly. It is this seeing with the naked eye (or other non-aided modes of perception) that van Fraassen calls observation. To van Fraassen an electron (if existing) is not observable. Since the 'continuum' argument does not hold (since to van Fraassen there are clear examples of observables and putative unobservables) there is no reason to accept the scientific realist view that in a bubble chamber we 'see' electrons. What we see are bubbles; this with the right (or in van Fraassen's view, wrong) metaphysical commitment can be taken to imply the detection of a putative microscopic entity. However, according to van Fraassen, there is no solid argument leading us to accept this conclusion.

In his discussion of the observable/unobservable dichotomy, van Fraassen mentions that, since observation refers to him to perception, the limitation on what is observable (i.e. the separation between the observable and the unobservable) is related to 'our limitations *qua* human being' (van Fraassen 1980, 17), which are described by scientific theories of perception. To van Fraassen the acceptance criteria for a theory is its empirical adequacy to what is observable. Since to van Fraassen to be observable is to be observable-to-us, and it is science that tells us what we can regard to be observable, there seems to be a problem of circularity in the definition of empirical adequacy of a theory (see, e.g. Musgrave 1985, 207-9; Muller 2004; Dicken and Lipton, 2006). Van Fraassen addresses this line of criticism in several places (see, e.g. van Fraassen 1985, 255-6; Monton and van Fraassen 2003; Muller and van Fraassen 2008). I will consider only the views presented in Monton and van Fraassen (2003), which I consider to be the most clear statement of van Fraassen's views concerning the threat of circularity.

As we have seen, in *The Scientific Image*, van Fraassen is clear when saying that observable is observable-to-us. This means that what is observable can change. According to van Fraassen what is observable depends on the epistemic community. If the epistemic community changes (for example due to the evolution of the specie) the 'line' between the observable and the unobservable can change. It is important to notice that this is a criterion that is independent of the accepted scientific theories (and what they might say about perception). According to van Fraassen the

observable/unobservable distinction is theory-independent. In particular van Fraassen considers that 'our opinions about what is observable will change as science changes. But that does not mean that what is observable changes too' (Monton and van Fraassen 2003, 411). The situation is such that in practice we need to rely on scientific theories to define what is observable; but in principle, independently of what the epistemic community is, what can be perceived (observed) by members of the community is theory-independent (Monton and van Fraassen 2003, 414). I will not provide any (positive) argument regarding this discussion, since according to the view to be presented here the observable/unobservable dichotomy is not tenable, which implies that this debate is meaningless.

Since with the *The Scientific Image* van Fraassen became an influential exponent of anti-realism, in part there was a shift of the burden of proof to the realist camp. An important contra-argumentation was made by Ian Hacking that put forward two (related) arguments for the observability of the unobservable. In the coincidence argument Hacking considers two samples of blood cells that are (to Hacking but not to van Fraassen) seen with two different microscopes: a light microscope and an electron microscope. The slices of blood cells are put on a microscopic grid (which importantly for my later argument is used to calibrate the electron microscope; see Seager 1995, 466). In both cases we see identical visual configurations. According to Hacking

> two physical processes – electron transmission and fluorescent re-emission – are used to detect the bodies. These processes have virtually nothing in common between them. They are essentially unrelated chunks of physics. It would be a preposterous coincidence if, time and again, two completely different physical processes produced identical visual configurations which were, however, artifacts of the physical processes rather than real structures in the cell. (Hacking 1983, 201)[2]

This argument from coincidence is reinforced by what Hacking call his argument of the grid. A barely visible peace of metal is supposed to be engraved with a checkerboard design through a particular technology from a large scale (more exactly a 'manipulative-by-us' scale) drawing of a grid. According to Hacking

> I know what I see through the microscope is veridical because we *made* the grid to be just that way. I know that the process of manufacture is reliable, because we can check the results with the microscope. (Hacking 1983, 203)

Van Fraassen (i think correctly) dismisses Hacking's argument due to its circularity (van Fraassen 1985, 297-8): we have a particular technological practice that is supposed to create micro-structures (that are unobservable). The only way we have to verify this is through a microscope, i.e. we must take for granted that the microscope enables seeing the unobservable (and according to van Fraassen there is no non-metaphysical argument that proves this). On the other hand if we use the supposed micro-grid to say that the microscope enables looking into the unobservable, we are (without any independent argument) accepting that a complex technological practice creates a defined micro-structure.

Hacking's arguments are, according to van Fraassen, unable to demonstrate that the microscopes are windows into the unobservable, and van Fraassen's distinction between the observable and the unobservable can be maintained.

If we do not see through/with a microscope what do we do then? According to van Fraassen the microscope (or any instrument used in experimental research) creates new observable phenomena:

> this is meant to be a change in view: assimilate those instruments as well, not to windows into the nether world, but to experimental arrangements that produce telling new effects for us to see and for us to give a place in our representations of the world. The instruments used in science can be understood as not revealing what exists behind the observable

[2] Van Fraassen dismisses this argument simply by calling the attention to the fact that 'we refer to two different sorts of instruments, so the sameness in the outputs must be attributed principally to similarities among the inputs. But no one doubts that it is in each case *blood samples* and not different kind of physical systems that were fed into the machines. This conclusion warrants no inference about the reality of the imputed unobservable structure' (van Fraassen 1985, 298).

phenomena, but as creating new observable phenomena to be saved. (van Fraassen 2001 , 154-55)

Paul Teller, while accepting this 'phenomena creation' view regarding most instruments, considers that there are important exceptions (Teller 2001). For example, to Teller the stethoscope and the (light) microscope enable to ear and see unobservable phenomena:

The details of heart murmurs and wheezing sounds symptomatic of damaged heart valves and pneumonia can not be distinguished by listening with ones ear pressed to the patient's chest. For these phenomena a stethoscope is required. (Teller 2001, 132)

We use microscopes to become aware of paramecia, mitochondria, cell walls ... not to produce images of which we separately become aware and then interpret as images of these things. (Teller 2001, 133)[3]

Van Fraassen does not accept Teller's views.[4] In any case he does not consider that the possibility of conceding to the view of optical microscopes as windows affects in any relevant way his views:

The main points of our discussion are not affected by just where precisely the line [between observable and unobservable] is drawn. I draw the line this side of things only appearing in optical microscope images, but won't really mind very much if you take this option only, for example, for the electron microscope. After all, optical microscopes don't reveal all that much of the cosmos, no matter how veridical or accurate their images are. *The empiricist point is not lost if the line is drawn in a somewhat different way from the way I draw it*. The point would be lost only if no such line drawing was to be considered relevant to our understanding of science. (van Fraassen 2008, 110)

Is then van Fraassen's observable/unobservable dichotomy safe? I think not. Let us return to Maxwell's argument of the continuum and van Fraassen's criticism of it. Maxwell basically presents without any argumentation the (for some) intuitive idea that there is a 'continuous series' (a term not really defined by Maxwell) that goes from seeing with the naked eye, seeing through a window or using glasses, seeing with an optical microscope, seeing with an electron microscope, and so on. The problem is that Maxwell does not provide any argument for what a 'continuous series' might be. Van Fraassen calls the attention to this point and makes the case that even if it is not possible to draw the line between the observable and the unobservable clearly it is possible to give clear examples of observable-to-us and unobservable-to-us that show, according to him, that the distinction between observable and unobservable is meaningful. In this way an apple is observable and an electron (if existing) is not. Contrary to Maxwell's realist argument we would have then an observable/unobservable dichotomy. As we will see next it is possible to give a meaningful definition of a 'continuous series' that goes from naked eye perception to aided perception with a series of instruments, in this way recovering (in part) Maxwell's intuition regarding seeing with instruments.

Van Fraassen undermined Hacking's coincidence argument by calling the attention to the fact that different instruments can be made to agree in their output when 'fed' with the same kind of input. This can be made clear by taking into account that scientific instruments of a particular 'class' are calibrated (between them and in relation to standard units) using a precise calibration procedure. For example the putative micro-grid that is 'seen' with the optical microscope is used in the calibration of the electron microscope so that there is a range in which both microscopes gives similar/equivalent results/images/access to the 'unobservable' (Seager 1995, 466). *It is the calibration that creates the 'continuous series'*. Loosely speaking, we can calibrate the optical microscope with the visual capacities of normal members of the epistemic community (as we can

[3] Teller regards his comments not as an indication that something is fundamentally wrong in the distinction between observable and unobservable, but as pointing to the need of a better empiricist notion of phenomenon (Teller 2001, 133-4).

[4] The details of van Fraassen's argumentation are not necessary to the ideas defended in this paper. They involve taking into account types of phenomena that van Fraassen had not considered previously, like rainbows, and reflections in the water, and making a parallel with the images seen in a microscope: 'it is these images that are like the rainbow (they cannot themselves be represented as independent things)' (van Fraassen 2001, 157).

use lenses to improve deficient visual capacities of 'non-normal' members). It is true that while we can see the hind end of an ant there is a point beyond which we cannot distinguish details of the structure without the optical microscope. But there is a range in which we can check what we see with the optical microscope with what we see with the naked eye. Van Fraassen does not provide an argument that shows there to be a relevant difference between the smaller structural feature a member of the epistemic community can distinguish and a more detailed view of these structural features only seen with the optical microscope. Contrary to van Fraassen's opinion it is relevant that it is not possible to draw the line between the observable and the unobservable clearly. There is a structural continuity in the features we see of the hind end of an ant with the naked eye and with the help of a microscope. There is no argument I know of that shows that there is a discontinuity between what is barely distinguishable by us and what is not distinguishable by us; also there is no argument I know of that shows that an instrument that in the visible range is calibrated to our vision (and that enables, up to what is barely distinguishable by us, to see the same as in naked eye vision) has a discontinuity exactly at the border between the seeable-to-us and unseeable-to-us, so that after the discontinuity it does not provide anymore a way of seeing barely visible things but a way of making images that are not anymore a direct seeing through/with the microscope. Since there is no convincing argument to the contrary, I consider that when calibrating the optical microscope to our vision we can extended our visual range into ranges beyond normal human capacity (i.e. into what van Fraassen calls the unobservable).

It is correct to consider that beyond the range of human vision we do not have a criteria to say that we see the structure as 'it really is' or somewhat changed by the instrument (i.e. it is not possible to compare on any equal basis the large-scale 'real' grid to its putative microscopic scale reproduction). However I consider that we cannot think of micro-structures in terms of what they would look like if they where visually perceptible by us, since they are not. In scientific realism it is implicit the metaphysical idea of an ontological structure of the world characterized by a spatial scale and things in relation to which we can zoom in/out our 'perceptual encounter' with them while maintaining the thing's identity as seen by us (i.e. the idea that things can be seen scale independently, which has implicit the acceptance that the word 'thing' is meaningful independently of the spatial scale); for example Paul Churchland considers that 'for any microscopic entity, one can in principle always change the relative spatial *size* ... so that the entity is observed' (Churchland 1985, 40). Why should we, from an anti-realist perspective, take it for granted that we can do that with, for example, micro-grids?

Contrary to van Fraassen's view, it really makes a difference if we consider that we see with an optical microscope. This is so because we can further extend the eye/glass/optical microscope 'continuous series' by calibrating the electron microscope to the optical microscope using for example the micro-grid (this can be done even if the question of what the grid really looks like does not have any meaning, since the answer would have to be made with an 'if': if the grid was somehow perceptible with the naked eye it would look like ...). This means that van Fraassen's observable/unobservable dichotomy cannot be made to stand.

Since the observable/unobservable dichotomy is presented by van Fraassen as fundamental to his constructive empiricism (since it is one of the central elements of van Fraassen's anti-realist definition of empirical adequacy), the breakdown of the dichotomy seems to bring down with it van Fraassen's constructive empiricism. I do not think that this is the case. The only thing that is breaking down besides the dichotomy are metaphysical commitments that were implicit in van Fraassen's philosophy without van Fraassen knowing it. We will look at this in the next section.

3. Is constructive empiricism possible without the observable/unobservable dichotomy?

As we have already seen van Fraassen did not see a threat in drawing the line between observable and unobservable beyond the optical microscope but 'recommended' it for the electron microscope. I really do not understand why the electron microscope? As we have seen in the introduction, van

Fraassen's 'problem' is with theoretical concepts like electrons that in (some versions of) scientific realism are taken to have ontological relevance. As mentioned in the previous section, when Teller was saying that we see through a optical microscope he did not consider his view to be endangering constructive empiricism, he was just calling the attention to the fact that 'we are a bit off on the wrong track in getting a hold of the relevant notion of phenomenon and experience' (Teller 2001, 134). Teller speculates that

> the relevant notion of phenomena and experience have more to do with the felt aspect of immediacy in experience than whether or not instruments have been used. I would speculate that what count for us as observable phenomena will have more to do with what we experience as unfolding in real time in our visual, auditory, and perhaps tactile sensory fields. (Teller 2001, 134)

I would risk saying that a fundamental aspect of our visual field is its spatiality:[5] we only see things, processes, events[6] in the context of a temporal involving spatial visual field. The electron microscope can give us visual access to spatial structures, not to putative fundamental building blocks of reality like classical fields, classical particles (e.g. the classical electron), quantum fields, quanta of a particular field (e.g. the unphysical bare electron), interacting fields (e.g. the electron as quanta of the Dirac field with its self-interaction due to the quantized electromagnetic field), absolute space, absolute time, the Minkowski spacetime, the curved spacetime of Einstein's theory of gravitation, Newtonian forces, an emergent spacetime as proposed in some quantum gravity speculations, and so on.

That is, when bringing down the observable/unobservable dichotomy if we do not lose sight of what visual perception might be (or at least of what visual perception cannot be) the extension of the observable into the realms of what van Fraassen was taking to be the unobservable-to-us does not entails the possibility of having a mediated-perceptive-contact with the putative ontological stuff prescribed by some realist interpretations of physical theories.[7]

This brings several questions: (1) why did van Fraassen felt the need of the dichotomy to protect us from theoretical postulated entities like electrons? (2) we still have a lot of instrumentation that give us access to the world (even if not extending directly our perception). Is it not possible to defend, without the dichotomy and according to realists, that, for example, in the case of the bubble chamber we detect electrons? (3) in this case is there a need for anti-realists to adopt a new dichotomy between observable-to-us (even if with the aid of particular instruments) and detectable-to-us (with the aid of a different set of particular instruments)?

Regarding the first question, as already hinted at in the previous section, van Fraassen shares much more than he would possibly want with the realists. Both agree in a commonsense realism of the observable world (*two* chairs *in* the room, a cat *on* the sofa, a post box *at* the corner, rain *falling down*, a morning that *was* cold, an afternoon that *is* less cold, and so on), even if there might be disagreement regarding what is the right description/representation to be adopted and its epistemological and ontological implications. But there is more. When van Fraassen adopts a two-world view of observable aspects of reality and unobservable aspects of reality he is inadvertently committing himself to the realist agenda in one of its more entrenched aspects, the already mentioned view that it is meaningful the idea of a spatial scale (eventually from infinitely small to infinitely large), and most importantly that there is a meaningful notion of scale invariance in the

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[5] The commonsensical idea that visual perception of common things (like apples, chairs, etc.) involves (qualitative) spatial aspects should not be confused with the idea of a (quantitative) space scale in which we could talk of spatial characteristics of micro-entities in similar terms as we due about common things. Both views can be discussable. However, the first fits well in a commonsensical realism that is not being disputed by constructive empiricism, while the second needs a realist metaphysical commitment (for example by endorsing an atomistic view of basic building blocks existing in a mathematically described space).

[6] This is the original' list' of types of phenomena mentioned in van Fraassen (1980). I do not consider his later amendments to the list, like his 'public hallucinations' and his distinction between phenomena and appearances, to change the situation in what regards the arguments developed in this paper (see, e.g., van Fraassen 2008)

[7] However, the weight of the argument should not depend on particular views on what visual perception might be. In this way, a further argument is presented below.

eventual perception of things (i.e. that there is a meaningful notion of size of a putative micro-thing and that the possibility of visual perception is independent of the 'relative' size of the thing in relation to us). When adopting this view it is not clear the difference between observation and detection as we see in Maxwell's argument. This in my view induces van Fraassen to stipulate a new dichotomy to enable him to implement his anti-realist intuition against accepting putative theoretical entities. In this way, the ontological agenda of realism is conditioning van Fraassen's anti-realism.[8]

Regarding the second question, by dropping the observable/unobservable dichotomy together with the related metaphysics there is no reason to consider that in a bubble chamber we are detecting, for example, electrons. On one side (*when adopting a notion that visual perception must have a spatial aspect, i.e. the spatiality of the visual field*) the 'new' argument of the continuum (with a meaningful notion of 'continuous series') does not imply that we can go all the way from our perception of commonsensical things to putative micro-entities (prescribed by physical theories); and on the other side (*independently of any adopted notion of visual perception*), it is clear that there is no possible calibration between instrumental aids to vision and different kinds of instrumentation used for 'detection', and this implies that there is no 'continuous series' connecting the visual perception of apples to the detection of electrons; due to this there is no reason to accept the view that, for example in the bubble chamber, we are indirectly observing real stuff. In fact, when dropping the dichotomy, we can adopt van Fraassen's views with a twist, i.e. that the majority of instrumentation creates new phenomena; that in general an instrument is not a window; and that when we are using, for example, electron microscopes (or whatever instrument we have in the end of a calibration sequence) it is fading away any meaningful notion and actual realization of a visual perceptual encounter with other aspects of the world (that are beyond ourselves). This is the case because we cannot calibrate a bubble chamber with a microscope, i.e. we cannot extend the specificity of instruments that are aids to perception to other types of instrumentation. All this implies that *without a previous metaphysical commitment there is simply no meaningful notion of unobservable-to-us*. Regarding the third question, this also means that we are not adopting a new observable/detectable dichotomy; these terms refer to different ways of encounter with the world. As van Fraassen notices, perception is first (van Fraassen 1980, 17; van Fraassen 2008, 93):[9] we see images in the computer screen, we see photos of (literally) bubbles in the bubble chamber. The word 'detection' is only philosophically relevant when adopting first a realist position; without it we can even drop this word in our accounts of experimentation as van Fraassen does (van Fraassen 1980, 74-7), and there is no new dichotomy neither any need for it. By dropping simultaneously the dichotomy and implicit realist metaphysical commitments the anti-realist views of van Fraassen can be maintained (in particular in what regards the impossibility of perception of putative micro-entities or its detection). In this way the possible viability of constructive empiricism does not depende on maintaining the observable/unobservable dichotomy.[10, 11]

4. Conclusion

The observable/unobservable dichotomy is apparently a fundamental structural feature of van Fraassen's constructive empiricism. I have argued that this dichotomy is not tenable. However by

[8] A similar point is made (from a different perspective) by Hasok Chang, who considers that 'the object-based definition of observability, which van Fraassen shares with many realists, introduces an unwarranted realist bias' (Chang 2005, 877).

[9] This does not means that van Fraassen adopts a naive empiricism. In his own words he is a stance empiricist (see, e.g., van Fraassen 2007, 366-8).

[10] From a different position, also Arthur Fine does not consider constructive empiricism to depend critically on drawing the line between observable and unobservable (Fine 2001, 113-5).

[11] However without the dichotomy the notion of empirical adequacy must be reworked; and it is an open issue (not addressed here) if it is possible to arrive at a coherent notion of empirical adequacy (which, even when accepting the dichotomy, is already being questioned by several authors; see, e.g., Teller 2001).

making explicit implicit metaphysical assumptions adopted by van Fraassen in putting forward his dichotomy, constructive empiricism seems possible without the observable/unobservable dichotomy.

This results opens the door to the possibility of a version of constructive empiricism that, following van Fraassen's own predicate (see, e.g., van Fraassen 1980, 73), has less metaphysical assumptions. My view is that the locus of the debate must move to the notion of empirical adequacy. We see that even van Fraassen's views regarding this point went through refinements (see, e.g., van Fraassen 2008), and that there are very different ways of addressing what empirical adequacy might be, in particular by questioning van Fraassen's semantic view of theories (see, e.g., Fine 2001) or by addressing the question of what notion of phenomena is meaningful for a coherent definition of empirical adequacy of scientific theories (see, e.g., Teller 2001; Massimi 2007). It is an open question how much a non-dichotomous view might lead to relevant changes regarding these approaches. However it would go beyond the scope of this paper to address it here.

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